

eBird Best Practices II

Occupancy Modeling

The **Cornell** Lab  of Ornithology

Occupancy models are used to estimate the true probability of a species **occurring** a site while accounting for imperfect **detection**

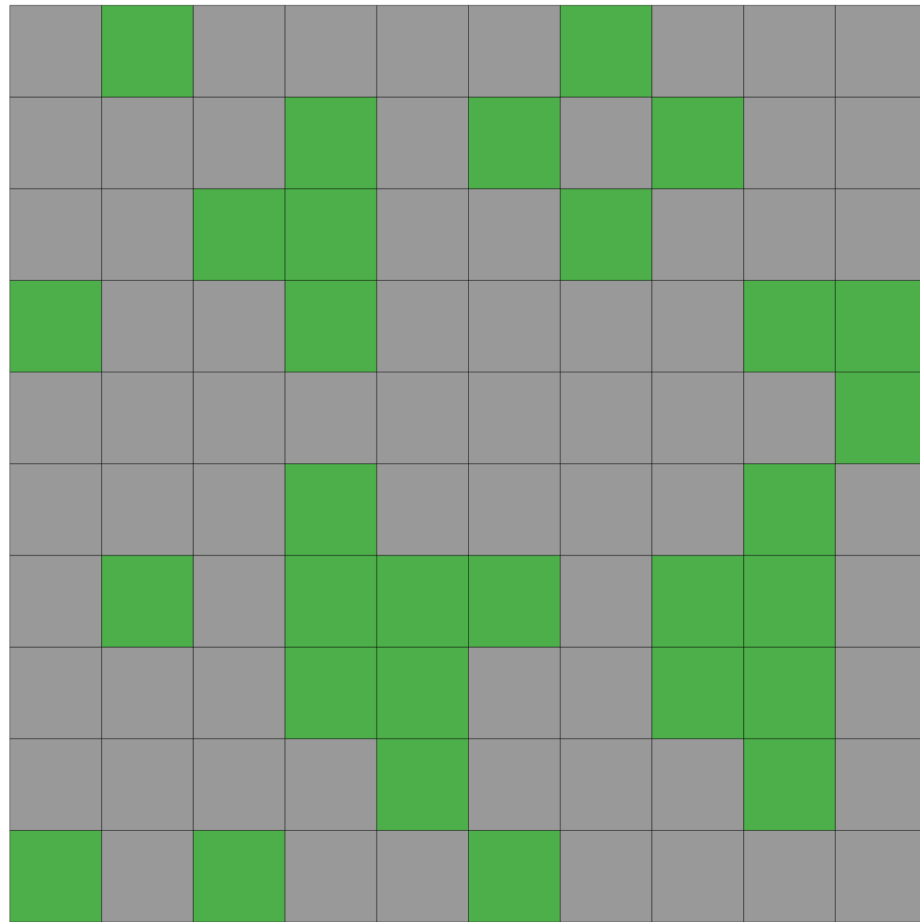
An observer recording a species at a site results from two processes

Ecological the species is present at that site

ψ = probability that the site is occupied

Observational the observer detected the species

p = probability of detection, given that the site is occupied

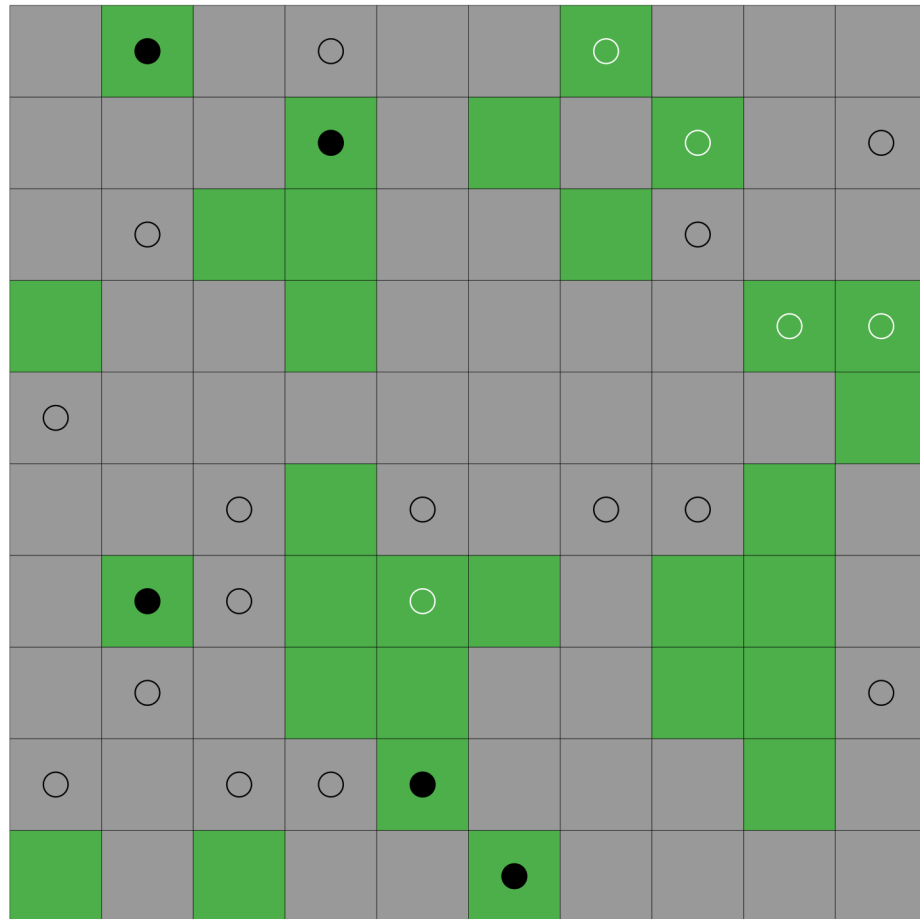


Site occupied No Yes

Occupancy for

$$n = 100 \text{ sites}$$

$$\psi = \frac{30}{100} = 0.3$$



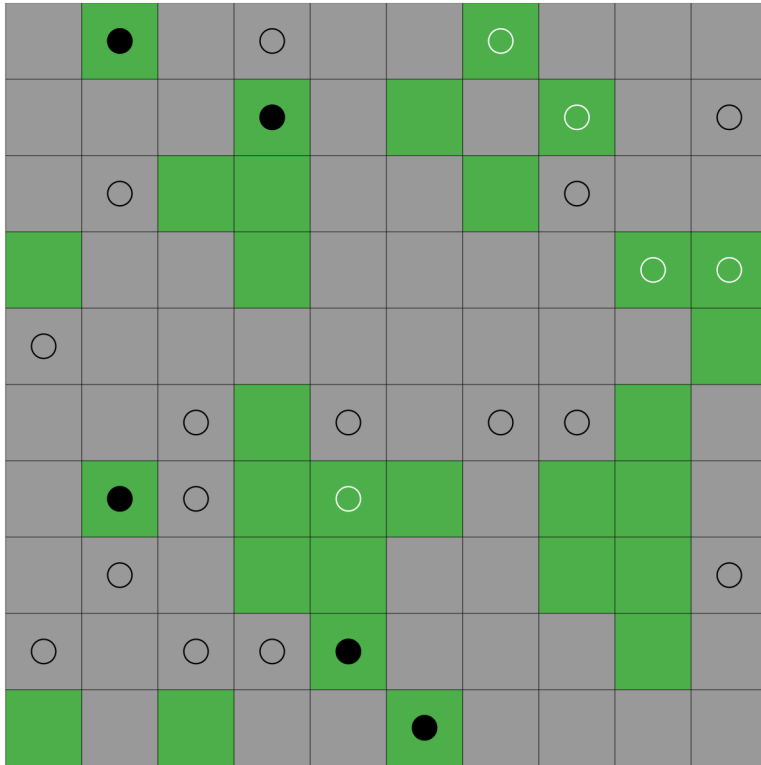
Species detected ○ No ● Yes

25 sites surveyed, non-detection can be due to:

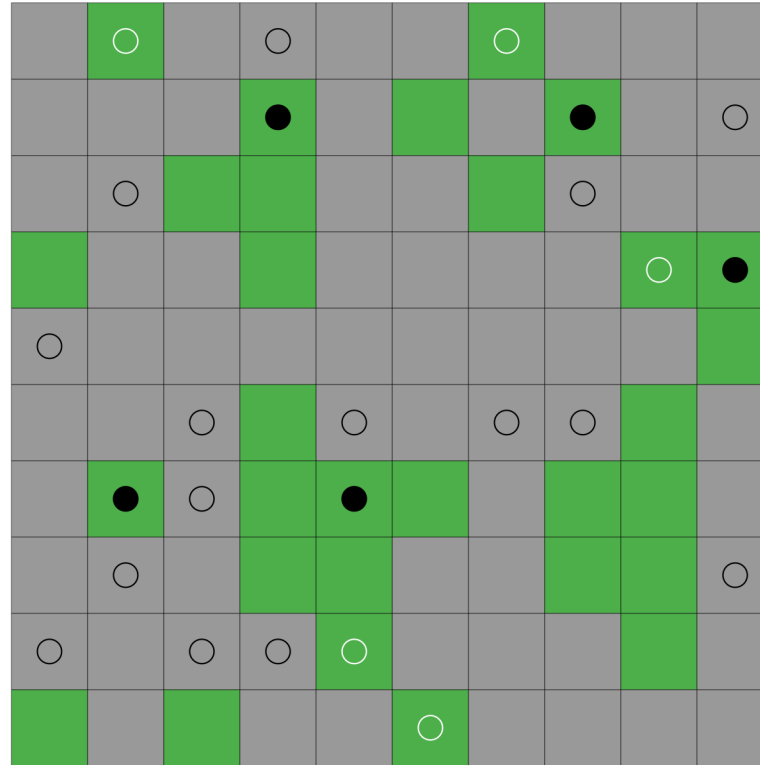
- Species not present (black)
- Species present, but not detected (white) because detection probability $p < 1$

Repeat sampling can be used to estimate the detection probability p

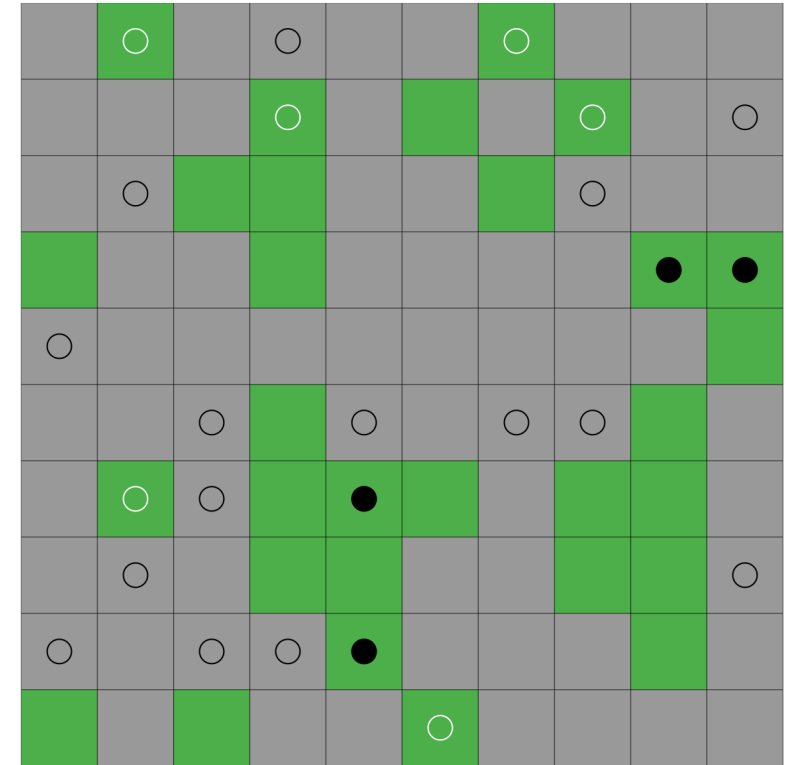
Visit 1



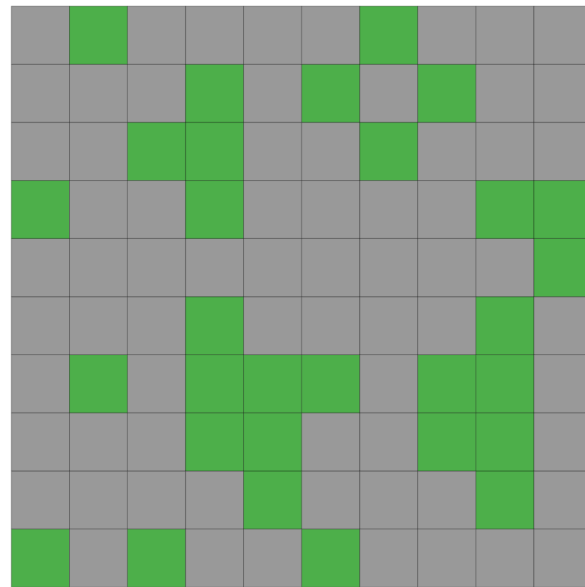
Visit 2



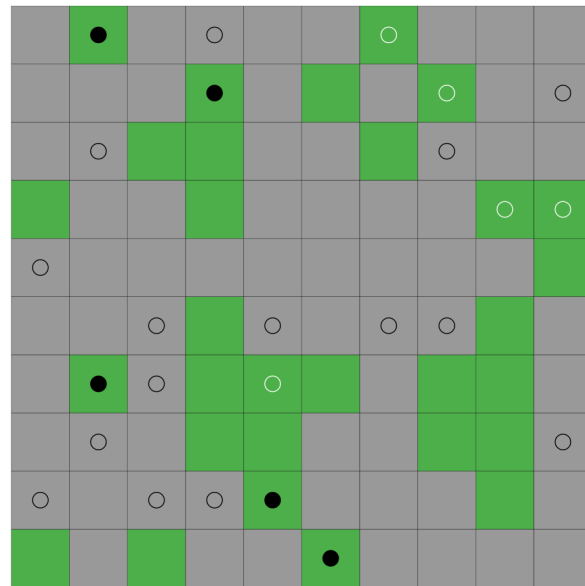
Visit 3



Species detected ○ No ● Yes



Site occupied ■ No ■ Yes



Species detected ○ No ● Yes

Ecological process

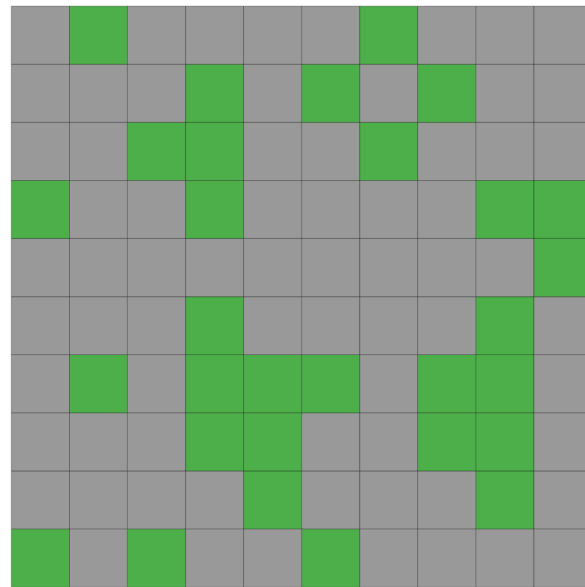
$$z_i | \psi_i \sim \text{Bernoulli}(\psi_i)$$

z_i = occurrence at site i

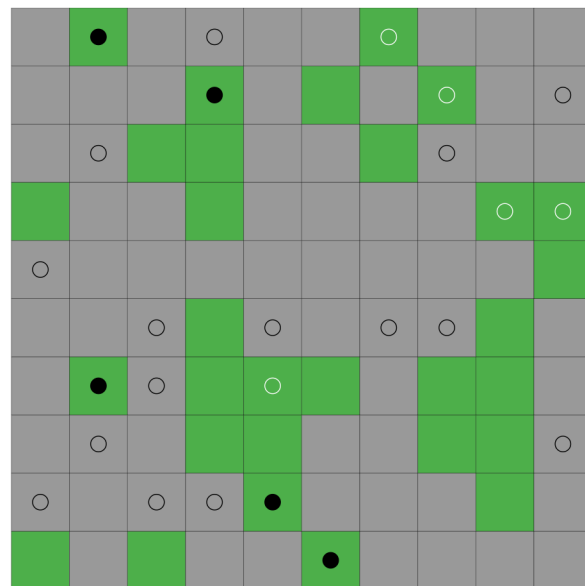
Observational process

$$y_i | z_i \sim \text{Bernoulli}(z_i p_{ij})$$

y_i = detection at site i



Site occupied ■ No ■ Yes



Species detected ○ No ● Yes

Ecological process

$$z_i | \psi_i \sim \text{Bernoulli}(\psi_i)$$

z_i = occurrence at site i

→ what we want to know

Observational process

$$y_i | z_i \sim \text{Bernoulli}(z_i p_{ij})$$

y_i = detection at site i

→ what we actually measure

Assumptions

- Repeated surveys occur during a period of **closure**, when there is no change in occupancy state
- There are **no false detections**
- Sites are **independent**
- The relationship between occupancy and detection probabilities and the covariates is **stationary**, i.e. constant across sites and visits